

## CLAIM AMENDMENTS

Claims 1 to 26 (cancelled).

1           27. (New) A method for the scheduling of a service  
2 resource shared among several information packet flows that  
3 generate respective associated queues, said flows including  
4 synchronous flows ( $i = 1, 2, \dots, N_s$ ) that require a guaranteed  
5 minimum service rate ( $r_i$ ) and asynchronous flows ( $j = 1, 2, \dots, N_A$ )  
6 that use the service capacity of said the resource that is left  
7 unused by the synchronous flows, method making use of a server and  
8 comprising the following steps:

9           (a) causing said server to visit the respective queues  
10 associated to said flows ( $i, j$ ) in successive cycles on the basis  
11 of a target rotation time value (TTRT), which identifies the time  
12 necessary for the server to complete a visit cycle on said  
13 respective queues;

14           (b) associating each synchronous flow ( $i$ ) with a  
15 respective synchronous capacity value ( $H_i$ ) indicating a maximum  
16 period of time for which the respective synchronous flow can be  
17 serviced before the server moves on;

18           (c) associating each asynchronous flow ( $j$ ) with a first

19     respective delay value ( $L_i$ ) that identifies a value that must be  
20     made up for the respective queue to have the right to be serviced,  
21     and a second respective value ( $last\_visit\_time$ ) that indicates an  
22     instant in which the server visited the respective queue in a  
23     previous cycle, determining for said respective queue, a time that  
24     has elapsed since the server's previous visit;

25             (d) servicing each queue associated to a synchronous flow  
26     (i) for a maximum service time relative to said respective value of  
27     synchronous capacity ( $H_i$ );

28             (e) servicing each queue associated to an asynchronous  
29     flow

30     (j) only if the server's visit occurs before the expected instant,  
31     said advance being determined as the difference between said target  
32     rotation time value (TTRT) and time that has elapsed since the  
33     server's previous visit and the accumulated delay; if positive,  
34     this difference defining a maximum service time for each  
35     asynchronous queue; and

36             (f) defining said respective synchronous capacity value  
37     ( $H_i$ ) for the queue associated to the  $i$ -th synchronous flow by  
38     insuring that:

39                     ( $f_i$ ) a sum of the synchronous capacity values

40 for said synchronous flows plus the duration of the longest packet  
41 services by said shared service resource ( $T_{max}$ ) does not exceed said  
42 target rotation time value (TTRT); and

43 ( $f_2$ ) said target rotation time value (TTRT) is  
44 not lower than a ratio of said longest packet serviced by said  
45 shared service resource ( $T_{max}$ ) to a complement to one of the sum  
46 over said synchronous flows of the minimum service rates  
47 ( $r_i$ ) required by said synchronous flows normalized to the service  
48 capacity (C) of said shared service resource.

1 28. (New) The method defined in claim 27 which includes  
2 the step of defining said respective synchronous capacity value  
3 ( $H_i$ ) for the queue associated to the i-th synchronous flow as the  
4 product of the minimum service rate required by said i-th  
5 synchronous flow ( $r_i$ ) and said target rotation time value (TTRT)  
6 normalized to the service capacity of said shared service resource  
7 (C).

1 29. (New) The method defined in claim 27 which includes  
2 the step of defining said respective synchronous capacity value  
3 ( $H_i$ ) for the queue associated to the i-th synchronous flow by:

4           defining a factor ( $\alpha$ ) such that the sum over said  
5       synchronous flows of the minimum service rates ( $r_i$ ) required by  
6       said synchronous flows normalized to the service capacity (C) of  
7       said shared service resource is not larger than the complement to  
8       one of said factor ( $\alpha$ ); and

9           defining said respective synchronous capacity value ( $H_i$ )  
10      for the queue associated to the i-th synchronous flow as said  
11      target rotation time value (TTRT) times the ratio of a first and a  
12      second parameter, wherein:

13                said first parameter is the sum of the number  
14      of said asynchronous flows ( $N_A$ ) and said factor ( $\alpha$ ), said sum times  
15      the minimum service rates ( $r_i$ ) required by said synchronous flows  
16      normalized to the service capacity (C) of said shared service  
17      resource, and

18                said second parameter is the sum of the number  
19      of said asynchronous flows ( $N_A$ ) plus the complement to one of the  
20      sum over said synchronous flows of the minimum service rates ( $r_i$ )  
21      required by said synchronous flows normalized to the service  
22      capacity (C) of said shared service resource.

30. (New) The method defined in claim 27 which includes the step of insuring that the sum over said synchronous flows of the minimum service rates ( $r_i$ ) required by said synchronous flows normalized to the service capacity ( $C$ ) of said shared service resource does not exceed unity.

31. (New) The method defined in claim 27 wherein said respective synchronous capacity value ( $H_i$ ) for the queue associated to the  $i$ -th synchronous flow is defined by satisfying:

i) the expressions

$$\sum_{i=1}^{N_s} H_i + \tau_{\max} \leq TTRT$$

$$TTRT \geq \frac{\tau_{\max}}{1 - \sum_{h=1}^{N_s} r_h / C}$$

ii) as well as the last one of the following expressions

$$H_i = \frac{r_i \cdot TTRT}{C} \text{ and}$$

$$H_i = \frac{(N_A + \alpha) \cdot r_i / C}{N_A + 1 - \sum_{h=1}^{N_s} r_h / C} \cdot TTRT$$

6 where:

7  $H_i$  is said respective synchronous capacity value ( $H_i$ ) for  
8 the queue associated to the  $i$ -th synchronous flow,

9 the summations are extended to all the synchronous flows,  
10 equal to  $N_s$ ,

11  $N_A$  is the number of said asynchronous flows,

12  $T_{max}$  is the duration of the longest packet service by said  
13 shared service resource,

14 TTRT is said target rotation time value,

15  $C$  is the service capacity of said shared service  
16 resource,

17  $r_i$  is the minimum service rate required by the  $i$ -th  
18 synchronous flow, with  $\sum_{h=1}^{N_s} r_h / C < 1$ , , and

19  $\alpha$  is a parameter that gives  $\sum_{h=1}^{N_s} r_h / C \leq 1 - \alpha$ .

1 32. (New) The device defined in claim 27 wherein during  
2 each of said successive cycles, said server performs a double scan  
3 on all the queues associated to said synchronous flows ( $i = 1, 2,$   
4  $\dots, N_s$ ) and then visits the queues associated to said asynchronous  
5 flows ( $j = 1, 2 \dots, N_A$ ).

1           33. (New) The device defined in claim 32 which includes  
2 the following steps:

3           associating with each synchronous flow (i) a further  
4 value ( $\Delta_i$ ) indicating the amount of service time that is available  
5 to the respective flow,

6           during a major cycle of said double scan servicing each  
7 queue associated to a synchronous flow (i) for a period of time  
8 equal to the maximum said further value ( $\Delta_i$ ), and

9           during a minor cycle of said double scan servicing only  
10 one packet of each queue associated to a synchronous flow (i),  
11 provided that said further value ( $\Delta_i$ ) is strictly positive.

1           34. (New) The device defined in claim 33 which includes  
2 the step of incrementing said further value ( $\Delta_i$ ) by said respective  
3 value of the synchronous capacity ( $H_i$ ) when the queue is visited  
4 during the major cycle of said double scan.

1           35. (New) The device defined in claim 33 which includes  
2 the operation of decrementing said further value ( $\Delta_i$ ) of the  
3 transmission time by each packet serviced.

1           36. (New) The device defined in claim 33 wherein the  
2 servicing of each queue associated to a synchronous flow (i) during  
3 the major cycle of said double scan ends when one of the following  
4 conditions occurs:

5           the queue is empty,  
6           the time available, represented by said further value  
7 ( $\Delta_i$ ), is not sufficient to service the packet at the front of the  
8 queue.

1           37. (New) The device defined in claim 36 which includes  
2 the operation of resetting said further value ( $\Delta_i$ ) when the  
3 respective queue is empty.

1           38. (New) The device defined in claim 33 which includes  
2 the step of decrementing the service time of said further value  
3 ( $\Delta_i$ ) in the presence of a service given during the minor cycle of  
4 said double scan.

1           39. (New) The device defined in claim 33 wherein during  
2 said double scan of all the queues associated to said synchronous



flows (I), said minor cycle ends when one of the following conditions is satisfied:

the last queue associated to a synchronous flow (i) has been visited,

a period of time not less than the sum of the capacities ( $H_i$ ) of all of the queues associated to said synchronous flows (i) has elapsed since the beginning of said major cycle of said double scan.

40. (New) The device defined in claim 33 which includes the step of initializing said further value ( $\Delta_i$ ) to zero.

41. (New) The device defined in claim 27 wherein in the case that said difference is negative, each said queue associated to an asynchronous flow (j) is not serviced and the value of said difference is accumulated with said delay ( $L_j$ ).

42. (New) The device defined in claim 27 wherein the service of a queue associated to an asynchronous flow (j) ends when one of the following conditions is satisfied:

the queue is empty,

5           the time available is not sufficient to transmit the  
6   packet that is at the front of the queue.

1           43. (New) The device defined in claim 27 wherein said  
2   first respective value ( $L_j$ ) and said second respective value  
3   (last\_visit\_time) are respectively initialized to zero and to a  
4   moment of startup of the current cycle when the flow is activated.

1           44. (New) A system for the scheduling of a service  
2   resource shared among several information packet flows that  
3   generate respective associated queues, said flows including  
4   synchronous flows ( $i = 1, 2, \dots, N_s$ ) that require a guaranteed  
5   minimum service rate and asynchronous flows ( $j = 1, 2, \dots, N_a$ )  
6   destined to use the service capacity of said resource left unused  
7   by the synchronous flows, the system including a server able to  
8   visit the respective queues associated to said flows ( $i, j$ ) in  
9   successive cycles, which is configured to perform the following  
10   operations:

11           determine a target rotation time value (TTRT) that  
12   identifies the time necessary for the server to complete a visiting  
13   cycle of said respective queues,

14           associate to each synchronous flow (i) a respective  
15       synchronous capacity value ( $H_i$ ) indicating the maximum amount of  
16       time for which a synchronous flow can be serviced before moving on  
17       to the next,

18           associate to each asynchronous flow (j) a first  
19       respective delay value ( $L_j$ ) that identifies the delay that must be  
20       made up for the respective queue to have the right to be serviced,  
21       and a second respective value (last\_visit\_time) that indicates the  
22       instant in which in the previous cycle the server visited the  
23       respective queue, determining for said respective queue, the time  
24       that has elapsed since the server's previous visit,

25           service each queue associated to a synchronous flow (i)  
26       for a maximum period of time relating to said respective  
27       synchronous capacity value ( $H_i$ ), and

28           service each queue associated to an asynchronous flow  
29       (j) only if the server's visit occurs before the expected instant,  
30       said advance being determined as the difference between said target  
31       rotation time (TTRT) and the time that has elapsed since the  
32       server's (10) previous visit and the accumulated delay difference,  
33       if positive, defining the maximum service time for each said  
34       asynchronous queue,

35           the system being configured to define said respective  
36       synchronous capacity value ( $H_i$ ) for the queue associated to the  
37       i-th synchronous flow by ensuring that:

38           the sum of the synchronous capacity values for said  
39       synchronous flows plus the duration of the longest packet serviced  
40       by said shared service resource (T) does not exceed said target  
41       rotation time value (TTRT); and

42           said target rotation time value (TTRT) is not lower than  
43       the ratio of said longest packet serviced by said shared service  
44       resource ( $T_{mm}$ ) to the complementary to one of the sum over said  
45       synchronous flows of the minimum service rates ( $r_i$ ) required by  
46       said synchronous flows normalized to the service capacity (C of  
47       said shared service resource.

1           45. (New) The system defined in claim 44 which is  
2       configured for defining said respective synchronous capacity value  
3       ( $H_i$ ) for the queue associated to the i-th synchronous flow as the  
4       product of the minimum service rate required by said i-th  
5       synchronous flow ( $r_i$ ) and said target rotation time value (TTRT)  
6       normalized to the service capacity of said shared service resource  
7       (C).

1           46. (New) The system defined in claim 44 which is  
2 configured for defining said respective synchronous capacity value  
3 ( $H_i$ ) for the queue associated to the  $i$ -th synchronous flow by:

4           defining a factor ( $a$ ) such that the sum over said  
5 synchronous flows of the minimum service rates ( $r_i$ ) required by  
6 said synchronous flows normalized to the service capacity ( $C$ ) of  
7 said shared service resource is not larger than the complementary  
8 to one of said factor ( $a$ );

9           defining said respective synchronous capacity value  
10 ( $H_i$ ) for the queue associated to the  $i$ -th synchronous flow as  
11 said target rotation time value (TTRT) times the ratio of a 30said  
12 first and a second parameter, wherein:

13           said first parameter is the sum of the number of said  
14 asynchronous flows ( $N_A$ ) and said factor ( $\alpha$ ), said sum times the  
15 minimum service rates ( $r_i$ ) required by said synchronous flows  
16 normalized to the service capacity ( $C$ ) of said shared service  
17 resource, and

18           said second parameter is the sum of the number of said  
19 asynchronous flows ( $N_A$ ) plus the complementary to one of the sum  
20 over said synchronous flows of the minimum service rates ( $r_i$ )

21 required by said synchronous flows normalized to the service  
22 capacity (C) of said shared service resource.

1 47. (New) The system defined in claim 44 which is  
2 configured for ensuring that the sum over said synchronous flows of  
3 the minimum service rates (ri) required by said synchronous flows  
4 normalized to the service capacity (C) of said shared service  
5 resource does not exceed unity.

1 48. (New) The system defined in claim 44 which is  
2 configured to define said respective synchronous capacity value  
3 ( $H_i$ ) for the queue associated to the i-th synchronous flow by  
4 ensuring that the following are satisfied:

5 i) the expressions

$$\sum_{i=1}^{N_s} H_i + \tau_{\max} \leq TTRT$$

$$TTRT \geq \frac{\tau_{\max}}{1 - \sum_{h=1}^{N_s} r_h / C}$$

i) as well as at least one of the following expressions

$$H_i = \frac{r_i \cdot TTRT}{C} \quad \text{and}$$

$$H_i = \frac{(N_A + \alpha) \cdot r_i / C}{N_A + 1 - \sum_{h=1}^{N_s} r_h / C} \cdot TTRT$$

where:

$H_i$  is the said respective synchronous capacity value

( $H_i$ ) for the queue associated to the i-th synchronous

flow,

the summations are extended to all the synchronous flows,

equal to  $N_s$ ,

$N_A$  is the number of said asynchronous flows,

$T_{\max}$  is the service duration of the longest packet by said

shared service resource,

TTRT is said target rotation time value,

C is the service capacity of said shared service

resource,

$r_i$  is the minimum service rate requested by the i-th

synchronous flow, with

, and

$$\sum_{h=1}^{N_s} r_h / C < 1,$$

$\alpha$  is a parameter that gives

$$\sum_{h=1}^{N_s} r_h / C \leq 1 - \alpha.$$

1           49. (New) The system defined in claim 44 wherein, during  
2 each of the said successive cycles, said server (10) performs a  
3 double scan on all the queues associated to said synchronous flow  
4 ( $i = 1, 2, \dots, N_s$ ) and then visits the queues associated to said  
5 asynchronous flows ( $j = 1, 2, \dots, N_a$ ).

1           50. (New) The system defined in claim 44 wherein:  
2 a further value ( $\Delta_i$ ), indicating the amount of service  
3 time available to the respective flow, is associated to each  
4 synchronous flow ( $i$ ),

5           during a major cycle of said double scan, each queue  
6 associated to a synchronous flow ( $i$ ) is serviced for a period of  
7 time equal to the maximum further value ( $\Delta_i$ ) , and

8           during a minor cycle of said double scan the system  
9 services only one packet of each queue associated to a synchronized  
10 flow ( $i$ ), provided said further value ( $\Delta_i$ ) is strictly positive.



1           51. (New) The system defined in claim 50 wherein said  
2 further value ( $\Delta_i$ ) is incremented by said respective synchronous  
3 capacity value ( $H_i$ ) when the queue is visited during the major  
4 double scan cycle.

1           52. (New) The system defined in claim 50 wherein said  
2 further value ( $\Delta_i$ ) is decremented by the transmission time of each  
3 packet serviced.

1           53. (New) The system defined in claim 50 which is  
2 configured so that the service of each queue associated to a  
3 synchronous flow (i) during the major cycle of said double scan  
4 ends when one of the following conditions occurs:

5           the queue is empty,

6           the time available, represented by said further value  
7 ( $\Delta_i$ ), is not sufficient to serve the packet at the front of the  
8 queue.

1           54. (New) The system defined in claim 53 wherein said  
2 further value ( $\Delta_i$ ) is reset when the respective queue is empty.

1           55. (New) The system defined in claim 50 wherein in the  
2 presence of a service given during the minor cycle of said double  
3 scan, said further value ( $\Delta_i$ ) is decremented by the amount of  
4 service time.

1           56. (New) The system defined in claim 50 wherein during  
2 said double scan on all the queues associated to said synchronous  
3 flows (i), said minor cycle ends when one of the following  
4 conditions is satisfied:

5           the last queue associated to a synchronous flow (i) has  
6 been visited,

7           a period of time not less than the sum of the capacities  
8 ( $H_i$ ) of all of the queues associated to said synchronous flows (i)  
9 has elapsed since the beginning of said major cycle of said double  
10 scan.

1           57. (New) The system defined in claim 50 wherein said  
2 further value ( $\Delta_i$ ) is initialized to zero.

1           58. (New) The system defined in claim 50 wherein, if  
2       said difference is negative, each said queue associated to an  
3       asynchronous flow (j) is not serviced and the value of said  
4       difference is accumulated with said delay ( $L_j$ ).

1           59. (New) The system defined in claim 50 wherein the  
2       service of a queue associated to an asynchronous flow (j) ends when  
3       one of the following conditions is satisfied:

4           the queue is empty,

5           the time available is not sufficient to transmit the  
6       packet that is at the front of the queue.

1           60. (New) The system defined in claim 50 wherein said  
2       first respective value ( $L_j$ ) and said second respective value  
3       (last\_visit\_time) are respectively initialized to zero and to the  
4       moment of startup of the current cycle when the flow is activated.